Ohio Agricultural Experiment Station

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ORCHARD BARK BEETLES AND PIN HOLE BORERS

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Bark Beetles, or Shot Hole Borers, cause more or less damage to fruit trees every year. They are particularly apt to attack weakened, scale-infested trees in cities, and in some seasons have been pests of the first order in the peach-growing belt along Lake Erie. Some kinds of trees, such as peach and cherry, exude large quantities of gum through the holes made by the beetles, and the surface of the bark may be coated over with pints to gallons of this gum, depending upon the severity of the attack and the size and vigor of the trees. Again, such trees as apple and pear do not gum at all under attack. The small white grubs burrow in characteristic fashion in the sapwood, often killing the trees, and the minute blackish or brownish beetles later issue through small openings in the bark resembling fine shot-holes. These beetles also do damage by entering the twigs at the bases of the buds and by making feeding burrows in the trunks and larger limbs of the trees of their choice. There are some related small beetles which bore into the heartwood and issue through minute holes resembling pin holes, from which they are sometimes known as pin hole borers.

The most common and destructive of all these small beetles, and the one that is universally distributed and plentiful everywhere in the state, is the Fruit Tree Bark Beetle, *Eccoptogaster rugulosus.*

*This circular is an abridgment of Bulletin 264, which gives full technical details regarding the bark beetle investigation. Parties desiring the detailed technical bulletin of over 70 pages, please apply to the mailing department.

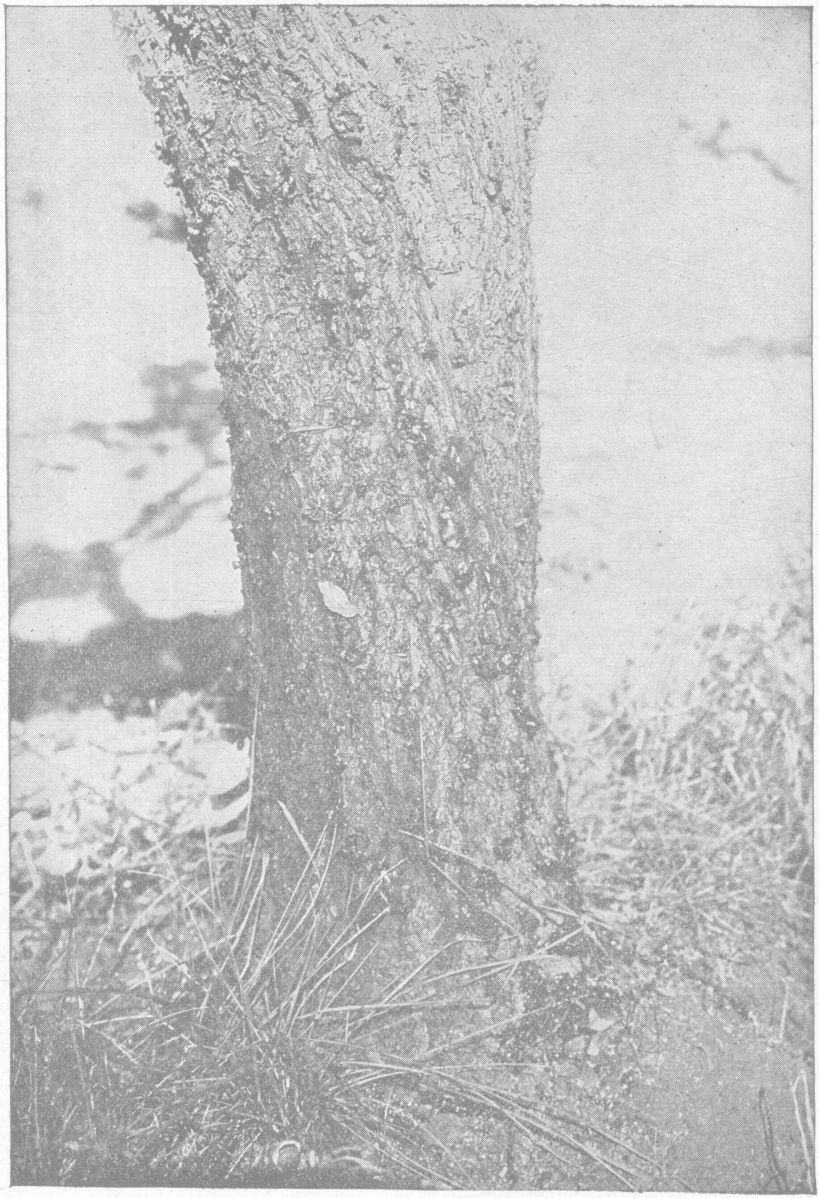


Plate I. Gumming from attack of Fruit Tree Bark Beetle on trunk of old tree.

FRUIT TREE BARK BEETLE OR SHOT HOLE BORER

Eccoptogaster rugulosus Ratz.

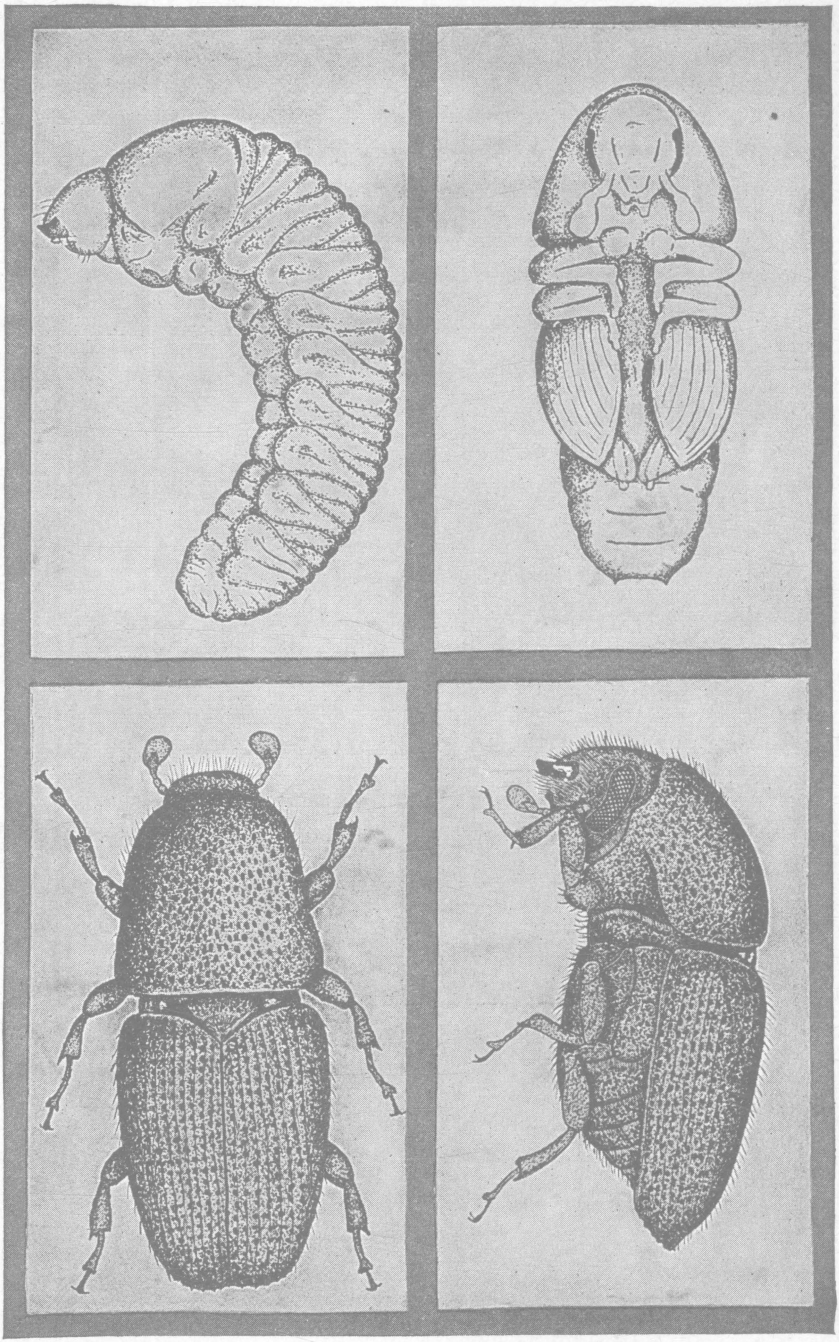
Often the first warning that comes to the fruit grower of the presence of this beetle is copious exudations of gum from his peach and cherry trees, and the sudden dying of a tree here and there that was supposed to be in good health. With apple and pear trees there may be no symtoms at all previous to the death of the trees, unless some paleness of the foliage and bark betokens that all is not well. Very soon, however, the tell-tale, shot-like holes through the bark make a diagnosis possible and positive as to the presence of this insect.

The original home of this beetle was in Europe, and it was imported into this country, being recognized in 1878, although it is known to have been introduced a few years earlier. It now occurs over all the eastern part of the United States, in Eastern Canada, over most of the Mississippi Valley, and in some of the Rocky Mountain States.

The adult beetle is a little less than one-tenth inch long and one-third as wide, color black, except the tips of the wing covers and lower parts of the legs; these being russet-red. The wing covers are grooved, the depressions being fitted with lines of minute punctures. The posterior margins of the wings have a saw-toothed edge. The head is vertical, the antennae, or feelers, short and strongly clubbed. The larva is a footless grub, whitish, often tinged with pink, transversely wrinkled, with a small brown or yellowish head. The anterior segments of the body are somewhat enlarged and the posterior tapering segments are bent downward as viewed from the back. Length, when full grown, about one-tenth of an inch.

LIFE HISTORY AND HABITS

Broods: In the spring the larvae may be found in cells which were excavated the preceding autumn, generally in the sapwood, but sometimes in the outer bark, and in these cells pupation occurs in early May. The larvae in these sapwood cells seem to be full fed and probably do no feeding in the spring, while those in the outer bark commence feeding in April and continue until they pupate. The pupation period is between May 7 and May 18 for the majority of the insects, and for the individual insects lasts 10 days to two weeks, at the end of which period the beetles emerge. The beetles of this first brood are observed in numbers during the first half of June, the extreme time limits extending from about May 20 to near the middle of July. Eggs are laid soon after the beetles appear and larvae of this generation are found during June and July. The beetles of the



—*J. L. King*

Plate II. Full grown larva, pupa, and dorsal and side view of beetle of *Eccoptogaster rugulosus*, greatly enlarged.

second brood commence appearing about the middle of July and continue to issue until late August, or early September. Stragglers of this brood may be found until late October. The second brood of larvae commence appearing in early August and the brood is in full swing early in September, though hatching may be continued until late September. This brood of larvae hibernates in the bark, finally maturing into the brood of beetles which issues the following May and June. No other than the larval stage has been found in northern Ohio during the winter. Thus, there are two broods of insects per year.

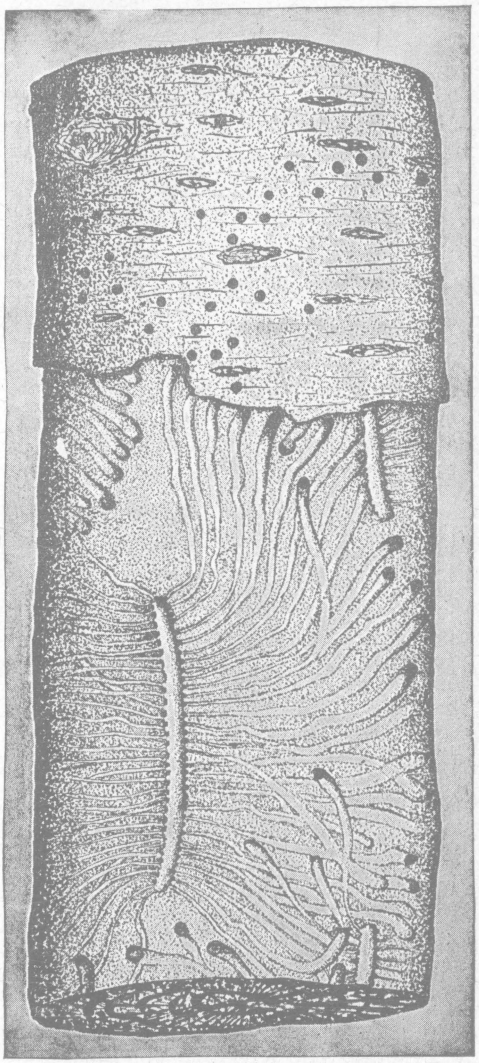


Fig. 1. Brood chamber and galleries of the Fruit Bark Beetle, *E. rugulosus*, natural size.

Food Habits: The female beetles obtain most of their food while boring through the bark to and from their brood chambers. Bark makes up the, greater part of their diet while the true wood forms only a small portion of their food. The burrows made in healthy trees are possibly started for the purpose of obtaining food, but may be primarily intended as trial brood burrows which are abandoned as soon as the beetles are inconvenienced by the vigorous flow of exuding gum. The beetles of the second generation bore into small twigs at the bases of the buds, probably to obtain food or shelter.

Brood Chambers: Very soon after issuing from the wood, the females begin the construction of their brood chambers, mating

occurring either before or after commencing the work. The entrance into the bark is often made through a lenticel, abrasion, or rough spot, and the burrow proceeds almost perpendicularly to the bark surface until the sapwood is reached. It is then turned and runs approximately parallel with the main axis of the trunk or limb, the main chambers being, on an average, about one inch long. Extending from it, at nearly right angles on each side, are the larval galleries, gradually excavated by the young grubs as they grow. Since crowding would result as the grubs increase in size, if the galleries were continued straight outward, they begin to incline endward more and more as they are prolonged, those nearest the ends being inclined the most, so that the terminal cells of the finished galleries roughly approximate an oval in arrangement as illustrated by the accompanying drawing (Fig. 1). The eggs are laid in parallel rows, one row on each side of the burrow, and the larvae construct the galleries. Since each female lays from 30 to over 100 eggs, the number of galleries will vary greatly. The average number of eggs laid per female is from 75 to 90. The galleries are from one to three or four inches long.

The openings to the burrows of these beetles are free from the webbed sawdust plug or cover which is found at the mouth of the burrows of *Phloeotribus liminaris*, the next species treated. The brood galleries are always made in dead or dying wood, or at least in sickly, weakened trees. Damage to healthy trees, as previously noted, is inflicted by feeding burrows made through lenticels or abrasions of the bark on trunk or branches, and by entering the twigs through holes made in the crotches of the leaves and of the winter buds, or through leaf scars. The gumming occasioned by these attacks may, in a few months, or after a year or two, so weaken the trees that they furnish suitable conditions for the construction of brood chambers and for the support of larvae.

HOST PLANTS

So far as recorded and observed in the United States, plum, peach, cherry, apple and pear may be considered preferred hosts in about the order named. Besides these, the quince, the apricot and the nectarine are attacked, and among uncultivated plants, the black cherry and the wild plum. Some European records give also hawthorn, elm and mountain ash.

PARASITES AND NATURAL ENEMIES

The most effective parasite is a minute, wasp-like insect, *Chiropachys colon*, which has been quite plentiful in the infested areas of Ohio. Woodpeckers are very fond of the larvae and devour great numbers of them during the winter and spring. Nematode worms sometimes inhabit the bodies of the larvae.

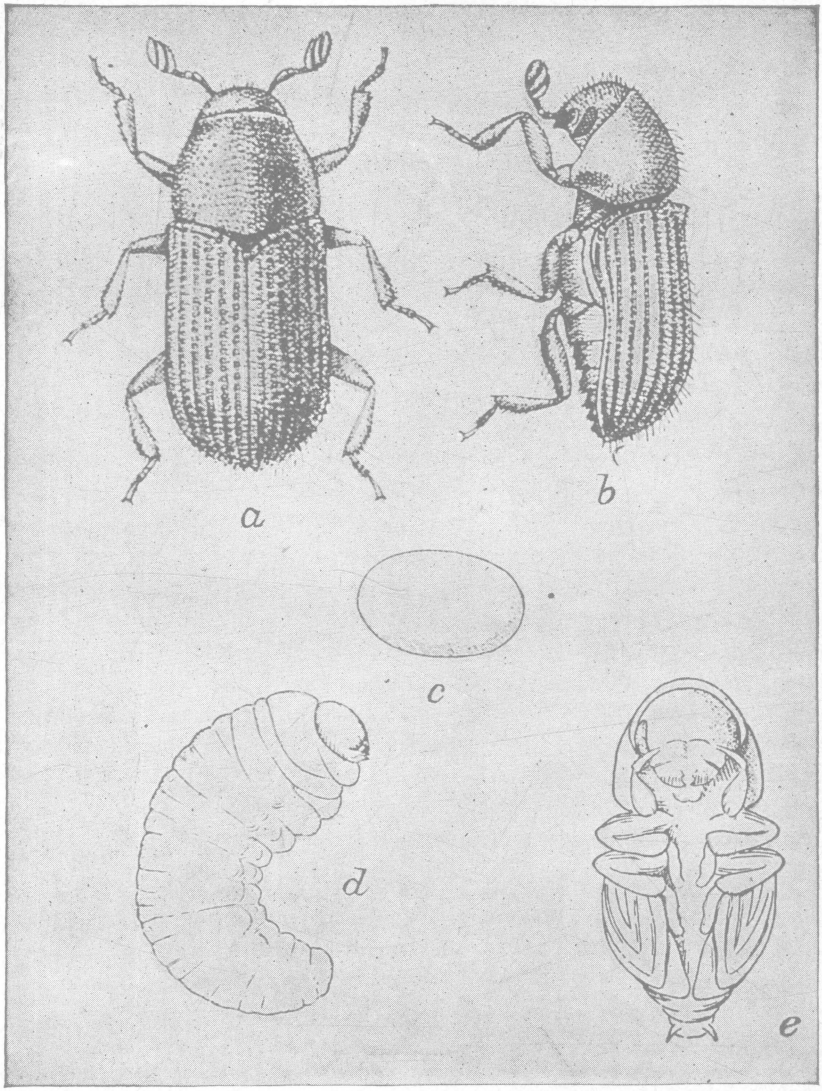


Plate III. Much enlarged figures of stages of Peach Bark Beetle, *Phloeotribus liminaris*: a and b, adult beetle; c, egg; d, larva; e, pupa. After Bur. Ent., U. S. D. A., Bul. No. 68, Part IX.

PEACH BARK BEETLE, *Phloeotribus liminaris* Harris.

This native American bark beetle has been known as a peach pest for over 60 years. Its work is so very similar to that of the Fruit Bark Beetle, previously treated, that the two are usually confounded and the work of this species is assumed to be that of the former; and the confusion is made the easier by the fact that both species may occur at the same time in the same orchard, or the two may commence a simultaneous onslaught on the same tree.

It has been taken in various parts of Ohio and is probably sparsely distributed over most of the state, but has never been a troublesome pest except in the fruit district lying along Lake Erie; here, it has in some years been quite as injurious, or more so, than the Fruit Bark Beetle. It has also been recorded in former years as a serious enemy to stone fruits in New York, Ontario, and several states to the east of Ohio.

DESCRIPTION

The beetle is slightly smaller than the Fruit Bark Beetle or Shot Hole Borer, being a little less than .09 inch long, and .03 inch wide. The color varies from light brown to almost black; wing covers deeply margined, sides parallel, surface with regular grooves in which are ranged numerous circular pits, the elevated parts with yellowish hairs arising from faint punctures. The underside of the abdomen is gradually concave, and in such contrast to the angle on the abdomen of *Eccoptogaster rugulosus*, where the posterior segments are suddenly reflexed backward and upward from the more forward ones, that this difference constitutes the most certain characteristic for quickly separating the two species.

LIFE HISTORY AND HABITS

In northern Ohio the hibernating beetles commence cutting their way out from their winter cells with the first warm days of spring, from late March onward, becoming generally active by the middle of April, or thereabouts, under average conditions. Both dead and living wood is used for hibernating cells, and when the beetles leave their winter shelters, they go to either dead or living trees, to wood piles, to brush heaps, or to any wood in which they can feed and rear their young. The entrance to the burrow is partially closed by a gummy exudate, mixed with bits of bark-dust and frass, the mass being bound together with a fine silken thread which is manufactured by both sexes. This mass, partially covering and extending somewhat into the burrow, is not found at the entrance to the burrows of *S. rugulosus*. The female commences burrowing into the bark, nearly always entering at a lenticel, and, if

the sap in the tree proves scanty, she constructs the brood chamber just between the sapwood and the bark; if, however, the sap is abundant, the galleries are confined to the bark, though sometimes impinging on the sapwood. The main chamber of the burrow may be anywhere from 1 inch to 2.625 inches long, the average length being about 2.06 inches. It is nearly always formed transversely across the trunk or limb, but is occasionally inclined at an angle of 45 degrees, or less, to the axis of trunk or branch. Since the main burrows of *Scolytus rugulosus* are more often than not vertical, or nearly so, there need not be much doubt as to which species formed any particular burrow. A fork is formed well toward the inner end of the burrow, commencing at the point where the burrow first touches the sapwood. When this point is struck, the female forms a little niche at an angle to the part already excavated, and she then begins excavating in the opposite direction, thus making another and approximately equal angle with the main burrow. A single pair, one female and one male, occupy each burrow, and only by rare accident will other beetles of this species be found in the burrow with them. The time consumed in constructing the brood chamber may vary from 10 days to 3 weeks and possibly, under unusual conditions, the period has yet wider limits in both directions. After

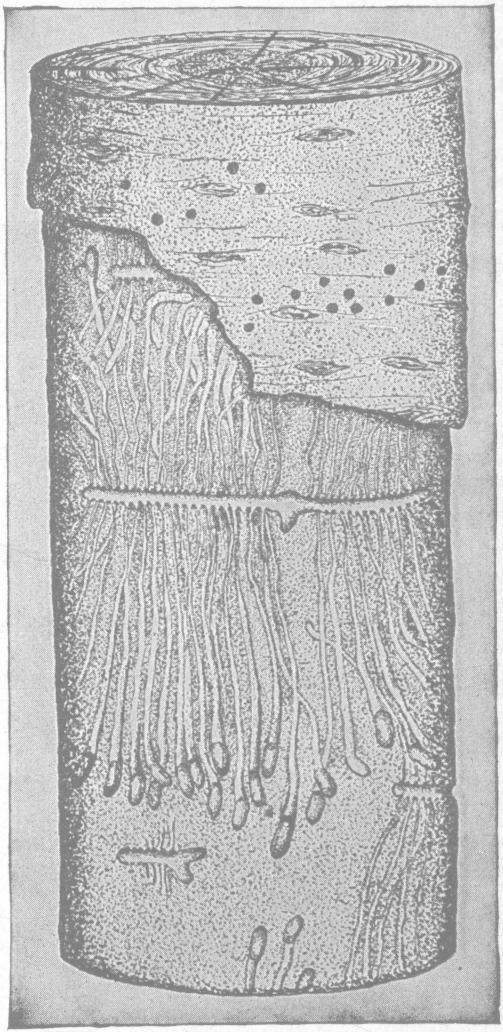


Fig. 2. Brood chamber and galleries of *P. liminaris.*

entering their brood chamber, the male and female of each pair seem to remain there until they die; they may sometimes be found in their burrows, feeble and sluggish, after some of their offspring have reached the beetle stage.

Along the sides of her burrow, the female excavates little niches which may be very close together or considerably separated. These cells are for the reception of eggs, one egg being deposited in each cavity. Thus there are two lines of eggs, each line following approximately the junction of the sapwood and the bark along each side of the burrow.

The burrow is extended gradually to accommodate the eggs as fast as they are ready to deposit. Deposition of eggs commences as soon as the female has been fertilized, which is generally within a week or so after activity has commenced in spring. Eggs are laid as early as May 2, and each female will lay from 2 to 10 per day until the completed brood chamber contains from 80 to 160. Owing to overlapping of the spring and summer broods, it is possible to find eggs any time from about the 20th of April until October 1. The white color of the young larva is soon suffused with pinkish, owing to bark particles in the digestive tract. The larvae excavate their galleries at right angles to the parent burrow, as shown in the accompanying illustration (Fig. 2). It will be noticed that the terminals of the galleries and, therefore, the exit holes, form an irregular ellipse around the brood chamber. The length of these larval galleries is from 1.5 inch to 2.875 inches. The larvae require from 25 to 30 days to become grown and when fully matured they burrow outward, making a pupal cell just beneath the outer surface of the bark. The pupae mature in from 4 to 10 days, then shed their skins and produce some very tender beetles. After becoming well hardened, which requires several days, or sometimes two weeks, they cut their way through the bark to the outside and appear as adults.

NUMBER OF BROODS

There are two complete broods per year in northern Ohio, the summer brood appearing about July 20, reaching a maximum during the latter part of August, and gradually dwindling to a few stragglers in late September and early October; and the fall or hibernating brood, which yields adults in October and November. From October until freezing weather, the fall adults are steadily emerging and migrating to growing trees. They enter such trees through rough places on the bark and excavate short burrows, from one-fourth to one-half inch or more in length. These burrows are closed in their outer course by the exudation of gum and the beetles

utilize the innermost ends as hibernation chambers. The latest formed or retarded adults hibernate in their pupal cells, not cutting their way out until the next spring. Hibernation, therefore, occurs in both living and dead wood, the emerged beetles making cells in the former, and the retarded beetles remaining in their pupal cells in the latter. There is a little overlapping of the summer and fall broods, so it seems there is no time in the year when at least a few beetles cannot be found, if infestation is general and severe.

FOOD PLANTS

The preference of this insect is for cultivated peach and cherry, next for wild cherry. It has also been found on mountain ash and on both cultivated and wild plum.

NATURAL ENEMIES

No parasites are known except a small nematode worm, which probably does not greatly inconvenience its host. Woodpeckers can be counted on to destroy the larvae along with other bark borers.

PIN HOLE AND TWIG BORERS

There is a considerable number of Scolytid beetles, other than the two species which we have treated at length, that work in the heartwood of trees as well as in the sapwood, most of them having a long list of hosts besides orchard trees. The external openings of their burrows resemble those of the bark beetles previously described, but, on the average, are smaller and suggest pin holes rather than shot holes. They may cause discoloration of the wood through which their burrows pass, the "blued" or stained areas exhibited by various timbers, when split, generally being caused by them. A fungus grows in the burrows of some of them, blackening the holes or burrows, which may be numerous enough to render otherwise valuable timber practically worthless. Both adults and young of some of the species are dependent for sustenance upon the fungus beds within their chambers. The beetles, therefore, become active and intelligent agents for the introduction and care of these fungus crops. Some of the more important of these borers are the Banded Pin-Hole Borer, *Monarthrum fasciatum* Say, the Apple Pin-Hole Borer or Apple Stainer,

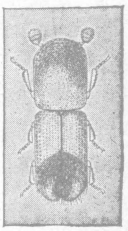


Fig. 3. *Monarthrum fasciatum*, enlarged. After Hubbard, Bur. Ent., U. S. D. A., Bul. 7, New Series.

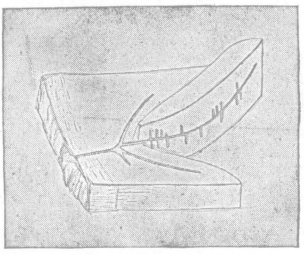


Fig. 4. Gallery of *M. fasciatum*, much reduced in maple. After Hubbard, Bul. No. 7, New Series, Bur. Ent., U. S. D. A.

Monarthrum mali Fitch, and the two Pear Blight Beetles, *Xyleborus dispar* Fabricus (Fig 7) and *Xyleborus pyri* Peck. The two species of *Monarthrum* occur in Ohio, as also probably do the two species of *Xyleborus*, but the latter are rarely encountered and the former are also observed infrequently.

Two species of Twig Borers belonging to the family of Powder Post Beetles are sometimes met with in this state. The largest is the Apple Twig Borer, *Amphicerus bicaudatus* Say, ranging from one-fourth to one-third inch in length. It is dark chestnut brown, almost black in color, and bores into small apple twigs in early spring, entering close beside a bud and excavating a channel down the pith which may be several inches long. Twigs of pear and cherry, also grape canes, are entered and killed in this manner. During the summer, the beetles generally leave their feeding burrows and deposit their eggs in the dead and dying roots of greenbriar or catbriar (*Smilax*), and in the dead shoots of grape.

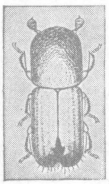


Fig. 5. *Monarthrum mali*, enlarged. After Hubbard, Bul. No. 7, N. S. Bur. Ent., U. S. D. A.

The other Twig Beetle, or Red-shouldered Sinoxylon, *Sinoxylon basilare* Say, is closely related to the Apple Twig Borer, but is considerably smaller, being about one-fifth of an inch long and has a large reddish spot on each wing cover. It injures the stems of grapes by boring into them, also the trunks and branches of peach and apple trees.

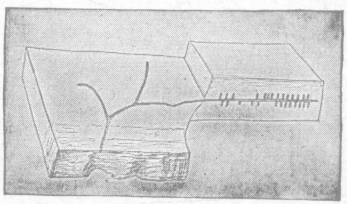


Fig. 6. Gallery of *M. mali*, much reduced. After Hubbard. Bul. No. 7, N. S. Bur. Ent., U. S. D. A.

REMEDIES

1. Create an unfavorable environment for propagation. As already observed in the body of this circular, old and neglected orchards that have died from the attacks of insects or disease, or which for any reason have become unprofitable and have been allowed to remain standing without care, furnish an ideal incubating ground for bark beetles. Likewise, unburned trimmings and woodpiles furnish excellent breeding facilities. It is, therefore, obvious that all orchard trees should be regularly trimmed each year, and all dead and sickly limbs, branches, and stubs, cut away and burned. Very weak trees, as well as dead ones, should be removed and burned. Trees dying in summer may be left as traps and cut late in the fall when full of larvae. Trees dying in the spring may either be cut and burned at once, or left as traps until filled with larvae, when they should be consumed; also, dying trees of varieties

susceptible to infestation in nearby wood-lots should be cut down and burned. If whole neighborhoods would cooperate in these clean culture measures, never through neglect omitting any of them, a general outbreak of these beetles, or even notable damage by them, would be very improbable, in fact, almost impossible.

2. Cultivation and Fertilization. Since both of these measures stimulate growth and increase the sap-flow, both help the trees to maintain a condition that is unfavorable to production of bark beetle brood, and the wounds made in such trees by the adults, to feed, are more quickly repaired than is the case with uncultivated and starved trees, when attacked. An abundance of barnyard manure is generally the best fertilizer. However, we have used some combinations of mineral fertilizer on our experimental blocks and have found that they possess some value. On poor land they would doubtless have proved of much greater value. For average Ohio conditions, the following formula, per acre, for home-mixing is recommended:

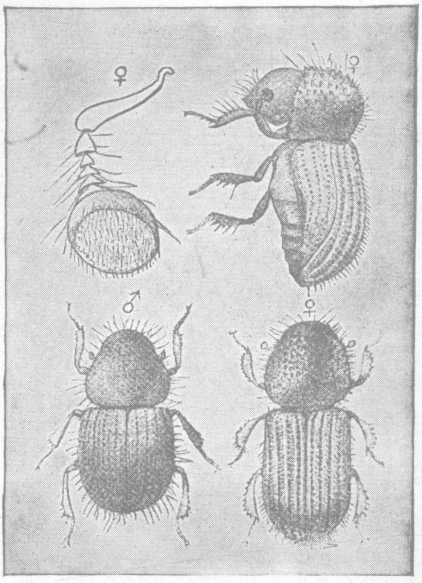


Fig. 7 *Xyleborus dispar* male and female adults, enlarged; antennae of female more enlarged. After Hubbard, Bul. No. 7, N. S., Bur. Ent., U. S. D. A.

100 pounds steamed bonemeal.
150 pounds acid phosphate.
70 pounds muriate of potash.
80 pounds nitrate of soda.

This to be distributed over a space several feet wider than the spread of the branches in order to stimulate a wider range of the feeding roots of the trees. The fertilizer should be applied as soon as the blossoms are expanded in the spring.

3. Whitewashing and similar treatments as preventives of attack. Whitewashing has proved of much value in preventing attack, but, under some circumstances, its effectiveness is much diminished. We have never known of trees in good general health that did not successfully throw off an attack, if carefully whitewashed two or three times per season through a period of two or three years. Old and decrepit orchards can generally be rejuvenated, if severely headed back to stubs, cultivated, and fertilized, and then

regularly whitewashed for a few years. If there is a nearby exhaustless breeding ground for bark beetles, this treatment may not avail. Thus we have sometimes had blocks of trees so circumstanced, that they continued to suffer and be reinfested with brood, notwithstanding a heavy coat of whitewash. Whitewash does not interfere in any way with larvae already beneath the bark, but fills up rough places in the bark, thus making it difficult for the females to satisfactorily place their eggs. Also, these beeetles, in common with most insects, dislike to expose themselves on a white surface. Whitewash may be made thin enough to apply with a spray pump, but it requires two or three successive applications, a day or so apart, to get a really protective coating. About 4 pounds of table salt to each 50 gallons of spray increases the sticking qualities. Most of our applications consisted of a thick whitewash, with one-fourth pound of salt to each 3 gallons, and these were made with a broom to the trunks and larger branches. If the beetles are excessively numerous in the neighborhood, make three applications during the season, the first by or before April 1st, the second about the middle of July, and the third by or a little before October 1st.

Of the other washes tried, Carbolineum Avenarius has been the most successful. Used in concentrated form, this material is too expensive for use, and is dangerous to the life of even healthy trees. We have seen several trees that were killed outright by being painted with undiluted material during the dormant winter period. In other cases, trees have survived the same treatment under apparently the same conditions without perceptible harm.

Emulsions of Carbolineum have apparently been somewhat more effective than whitewash, for repelling the insects, and in case of severe attack the extra cost seems to us to be warranted by the results, especially when valuable trees are endangered. The most successful formula we have used for making an emulsion is as follows:

Dissolve 4 pounds of naptha soap in 4 gallons of water, and while this is boiling hot, remove from the fire and add one gallon of Carbolineum Avenarius, agitating with a force pump, or for small quantities, with a rotary egg-beater, exactly as if preparing kerosene emulsion. When well emulsified, add 3 gallons of hot water and apply while warm to the trunks and larger limbs of the trees. Keep face and hands well protected and horses well blanketed when applying this emulsion, and work only on the windward side of the trees, as it is very penetrating and is likely to cause blistering and sloughing off of the skin, should this become wetted with it. These emulsions of Carbolineum seem not to have injured the trees in any

case, but, on the contrary, appeared to exert a stimulating effect in nearly all cases. The spray must not be applied to the foliage, and applications should be made at the dates recommended for whitewashing.

Dr. James Fletcher, late Entomologist of the Canadian Department of Agriculture, in the 26th Report of the Entomological Society of Ontario, 1895, makes the following observations which indicate that a treatment closely paralleling that used by us was successfully used on the Canadian side of the lakes:

"The Peach Bark Borer (*Phloeotribus liminaris*) which for some years has done so much harm in the peach orchards of Niagara peninsula, has this year been successfully treated by Mr. C. E. Fisher, of Queenstown. Noticing that the perfect beetles become active very early in the spring, he would wash his trees with a strong alkaline wash to which carbolic acid had been added. He made his wash as follows: Five pounds of washing soda, three quarts of soft soap and enough water to make six gallons. Air-slaked lime was then added sufficient to make it of the consistency of thick paint. To all this was added three teaspoonfuls of Paris green and one ounce of carbolic acid. This mixture was applied with a whitewash brush, thoroughly covering the entire trunk of the tree and a few inches up on the limbs. Mr. Fisher reports that at the end of the season he is quite satisfied with the results of the treatment. It would appear from what I have just said that two applications of this mixture, the first one being made as soon as the beetle becomes active, sometimes as early as March, and another six weeks later, would provide us with an effective remedy for this little pest, which for some years has done considerable harm in our Canadian peach orchards."

REMEDIES FOR PIN HOLE AND TWIG BORERS

For the Pin Hole Borers the remedies given for bark beetles are very applicable. Driving wooden pegs or wire nails into the pin holes may be used as supplementary treatment if thought desirable. Bisulfide of carbon may be injected into the burrows before they are closed, mud, putty, or grafting wax being used instead of pegs or nails to close the orifices. Possibly poles, stuck into the ground, would be utilized by the beetles for breeding and thus serve as traps. In case of severe attack the trunks and larger branches might be protected by being wrapped with newspaper, or old cloths, but for large scale treatment the orchardist will obviously have to depend largely upon keeping his trees in a healthy condition, as free as possible from mechanical injuries and abrasions, and on some such operation as whitewashing.

Twigs containing the twig borers should be cut out and burned, and wild grape, catbriar and other plants specially sought out for incubation purposes, should be exterminated from the near vicinity of orchards.

The remedial recommendations herein set forth are based on several season's experience and we are satisfied they are trustworthy for general adoption.

ACKNOWLEDGMENTS

We are indebted to Dr. L. O. Howard and Prof. A. L. Quaintance, of the Bureau of Entomology, U. S. Department of Agriculture for assistance during the season of 1908, Mr. H. F. Wilson having been employed and paid by the Bureau, for that season, to study the life histories and economy of the bark beetles in the territory centering about the Marblehead Peninsula. The field expenses were borne by the Station. Mr. Wilson furnished copious notes and made important treatment tests for the two most important species, reporting the life history of the Peach Bark Beetle in Part IX Bul. 68, Bur. Ent., U. S. D. A. Since 1908. Messrs. L. L Scott W. H. Goodwin, R. D. Whitmarsh the writer, and especially J L. King have contributed observations and experimental notes all of the work being directed by the author: Mr. King has furnished all the drawings and photographs used herein, except where otherwise accredited; to all of these and to many residents of the Lake Shore district, especially to Mr. W. H. Wright of Lakeside, and Mr. Wm. Miller of Gypsum, we hereby tender our hearty thanks.